

**Level 2A**  
**Software Development Document**

**for the**

**Sounding of the Atmosphere  
using Broadband Emission Radiometry  
(SABER)**

***(Draft)***

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# SABER Level 2A Software Development Document

## 1. Scope

This Software Design Document (SDD) describes an overall design plan for SABER Level 2A processing software. The software retrieves geophysical parameters, chemical constituents, and key emission features important in understanding the energy budget of the mesosphere and lower thermosphere. The Level 2A Routine Products are retrieved from measured radiances, read from the Level 1B file, and auxiliary input data from an instrument characterization file, climatological data, and spectroscopic and kinetics databases. The Routine Products are output to a daily NetCDF file.

## 2. Referenced Documents

### GIS

Level 1B format document  
Level 2A format document

## 3. System Overview

The SABER Level 2A data flow is shown in Figure 1. The Level 1B file is NetCDF format and is described in the Level 1B Format Document. It contains radiance data geolocated and gridded to common angle & height scales.

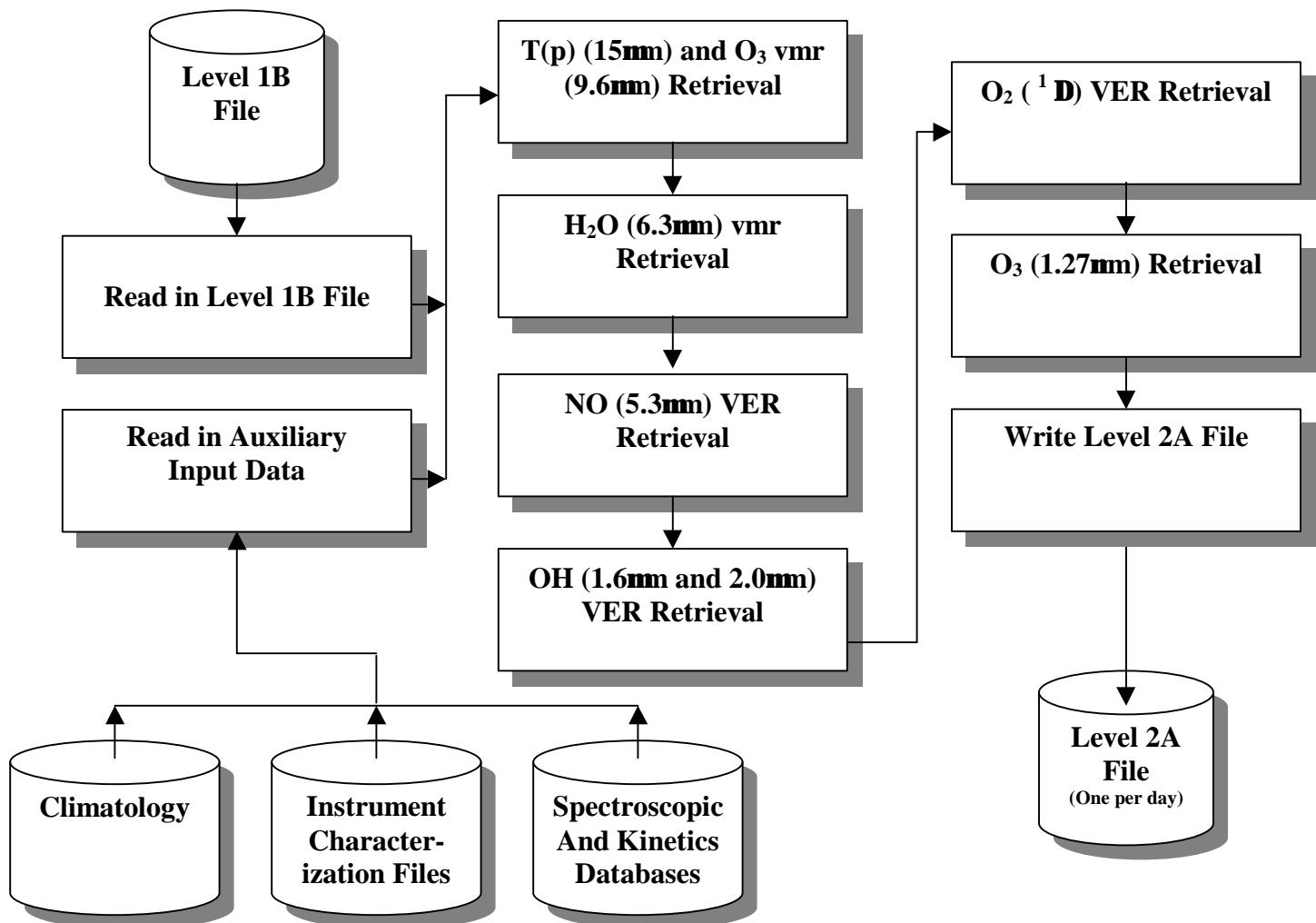


Figure 1: SABER Level 2A Dataflow

## **4. System Requirements**

The Level 2A software must be able to run on Linux workstations. It must be able to read and write files across the Internet via NFS.

## **5. Computer Software Configuration Items**

The requirements for each CSCI shown in Figure 1 are presented below.

### **5.1 CSCI: Read in Level 1B Files**

This CSCI reads data from the SABER 1B file. The data are read into a format that the Level 2A system can use for processing.

#### **5.1.1 Requirements**

The CSCI must open and read a Level 1B file. The data are stored by scanning event and channel identification number.

#### **5.1.2 Testing**

Use debugger to dump data read in for comparison with Level 1B file.

### **5.2 CSCI: Read in Auxiliary Inputs**

This CSCI reads auxiliary input data required to retrieve Level 2A Routine Data Products. The data are read into a format that the Level 2A system can use for processing.

#### **5.2.1 Requirements**

The CSCI must open and read data from the instrument characterization file, climatological database, and the spectroscopic and kinetics databases. The auxiliary data are free ASCII format. The instrument characterization file is supplied from Level 1 processing.

#### **5.2.2 Testing**

Use debugger to dump data read in for comparison with auxiliary input data files.

### **5.3 CSCI: T(p) (15um) and O3 (9.6um) Retrieval**

This CSCI retrieves T, p, and O3. Other quantities computed from the retrieved T(p) are ? and z. The retrieved and computed quantities are passed to all subsequent CSCI's.

#### **5.3.1 Requirements**

The CSCI must retrieve T, p, and O3 for each scanning event supplied by the Level 1B file. The CO2N and CO2W 15um channels are used to retrieve T and p. From the retrieved T(p), ? and z are computed.

#### **5.3.2 Testing**

Synthetic Level 1B radiances will be generated from a model atmosphere (e.g. from the climatology database). T(p) and O3 will be retrieved from the synthetic radiances and compared to the model atmosphere.

### **5.4 CSCI: H2O (6.3um) Retrieval**

This CSCI retrieves H<sub>2</sub>O mixing ratio at 6.3um.

#### **5.4.1 Requirements**

The CSCI must retrieve H<sub>2</sub>O for each scanning event supplied by the Level 1B file. The retrieved T(p) from Section 5.3 is required.

#### **5.4.2 Testing**

Synthetic Level 1B radiances will be generated from a model atmosphere (e.g. from the climatology database). H<sub>2</sub>O will be retrieved from the synthetic radiances and compared to the model atmosphere.

### **5.5 CSCI: NO (5.3um) VER Retrieval**

This CSCI retrieves NO VER at 5.3um.

#### **5.5.1 Requirements**

The CSCI must retrieve NO VER for each scanning event supplied by the Level 1B file. The retrieved T(p) from Section 5.3 is required.

#### **5.5.2 Testing**

Synthetic Level 1B radiances will be generated from a model atmosphere (e.g. from the climatology database). NO VER will be retrieved from the synthetic radiances and compared to the model atmosphere.

### **5.6 CSCI: OH (1.6um and 2.0um) VER Retrieval**

This CSCI retrieves OH VER at 1.6um and 2.0um.

#### **5.6.1 Requirements**

The CSCI must retrieve OH VER for each scanning event supplied by the Level 1B file. The retrieved T(p) from Section 5.3 is required.

#### **5.6.2 Testing**

Synthetic Level 1B radiances will be generated from a model atmosphere (e.g. from the climatology database). OH VER at 1.6um and 2.0um will be retrieved from the synthetic radiances and compared to the model atmosphere.

### **5.7 CSCI: O<sub>2</sub> (<sup>1</sup>D) (1.27um) VER Retrieval**

This CSCI retrieves O<sub>2</sub> (<sup>1</sup>D) VER at 1.27um.

#### **5.7.1 Requirements**

The CSCI must retrieve O<sub>2</sub> (<sup>1</sup>D) VER for each scanning event supplied by Level 1B file. The retrieved T(p) from Section 5.3 is required..

#### **5.7.2 Testing**

Synthetic Level 1B radiances will be generated from a model atmosphere (e.g. from the climatology database). O<sub>2</sub> (<sup>1</sup>D) VER will be retrieved from the synthetic radiances and compared to the model atmosphere.

## **5.8 CSCI: O3 (1.27um) Retrieval**

This CSCI retrieves O3 mixing ratio during daytime from the O<sub>2</sub> (<sup>1</sup>Δ) (1.27um) VER and O3 (9.6um).

### **5.8.1 Requirements**

The CSCI must retrieve O3 mixing ratio for daytime scanning events supplied by Level 1B file. The retrieved T(p) and O3 mixing ratio (below 50 km) from Section 5.3 is required. The retrieved O<sub>2</sub> (<sup>1</sup>Δ) VER from Section 5.7 is also required.

### **5.8.2 Testing**

Synthetic Level 1B radiances will be generated from a model atmosphere (e.g. from the climatology database). O3 (1.27um) will be retrieved from the synthetic radiances and compared to the model atmosphere.

## **5.9 CSCI: Write Level 2A File**

The CSCI writes SABER Level 2A Routine Products to NetCDF file.

### **5.9.1 Requirements**

The CSCI must write the Level 2A Routine Products described in Sections 5.3 through 5.8 to a NetCDF file. The Level 2A file is described in the Level 2A format document.

### **5.9.2 Testing**

Read Level 2A NetCDF file and compare to an ASCII file with the same data.

## **6. Acronym and Symbol List**

CO2N	Carbon Dioxide Narrow Channel
CO2W	Carbon Dioxide Wide Channel
CSCI	Computer Software Configuration Items
GIS	
H2O	Water Vapor
O2	Oxygen
O3	Ozone
OH	Hydroxyl
NO	Nitric Oxide
NSF	Network File Server
P	Pressure
?	Atmospheric Density
SABER	Sounding of the Atmosphere using Broadband Emission Radiometry
SDD	Software Design Document
T	Kinetic Temperature
Um	Micrometer
VER	Volume Emission Rate
Z	Altitude

## 7. Appendix A: SABER Level 2A File Format Description

### PURPOSE

The purpose of this appendix is to define the content and format of the SABER Level 2A file. This file will be a product produced by the SABER Level 2A processing software. It will contain routine retrieved profiles for each SABER constituent listed in the Level 2A Software Development Document. The Level 2A file will be in the NetCDF format.

### BACKGROUND

The Level 2A file will be the output from Level 2A processing, which reads in a Level 2A file and performs iterative retrievals for each constituent.

### REQUIREMENTS

The Level 2A file will contain retrieved profiles as a function of pressure, altitude, angle, latitude, longitude and time. Other derived requirements include:

- Event number for current day
- Day/Night flag for tangent point
- Orbit Ascending/Descending flag
- Solar Zenith Angle at Tangent point
- Solar Ap, Kp, F10.7 and sunspot number

### FORMAT

Following the Common Data form Language (CDL) definition of a NetCDF file, the Level 1B will contain:

- **Dimensions**

```
event = 1-2200; // Scan event number for current day (~2200)
altitude=500; // Tangent point altitude (km)
```

- **Variables**

```
short event(event) // Event number for current day
long date(event) // Date (YYYYDDD)
float elevation(altitude) // Elevation Angle (SABER centric)
long time(event, altitude) // Msec since midnight
char mode(event) // 0=Down 1=Up
float slatitude(event, altitude) // Spacecraft latitude (degrees)
float sclongitude(event, altitude) // Spacecraft longitude (degrees)
float scatitude(event, altitude) // Spacecraft altitude (km)
float latitude(event, altitude) // Tangent point latitude
float longitude(event, altitude) // Tangent Point longitude
char tpDN(event) // 0=Day 1=Night
char scAD(event) // 0=Ascending 1=Descending
float tpSolarZen(event) // Tangent point solar zenith angle (degrees)
float tpSolarLT(event) // Tangent point local solar time (msec since
midnight UT)
float pressure(event, altitude) // Pressure (mbar)
float pressure_error(event, altitude) // Pressure error (mbar)
float Ktemp(event, altitude) // Kinetic temperature (K)
float Ktemp_error(event, altitude) // Kinetic temperature error (K)
float density(event, altitude) // Atmospheric Density (m/v)
float density_error(event, altitude) // Density error (m/v)
float o3L(event, altitude) // Ozone mixing ratio (9.6 um channel) (ppmv)
float o3L_error(event, altitude) // Ozone mixing ratio error (ppmv)
float o3S(event, altitude) // Ozone mixing ratio (1.27 um)(ppmv)
float o3S_error(event, altitude) // Ozone mixing ratio error (ppmv)
```

```

float H2O(event, altitude)                                // Water Vapor Mixing Ratio (ppmv)
float H2O_error(event, altitude)                           // Water Vapor Error (ppmv)
float NOe(event, altitude)                               // Nitric Oxide volume emission rate (Units?)
float NOe_error(event, altitude)                          // Nitric Oxide volume emission rate error ()
float OHLe(event, altitude)                             // Hydroxyl volume emission rate (2.0 um channel)()
float OHLe_error(event, altitude)                        // Hydroxyl volume emission rate error ()
float OHSe(event, altitude)                            // Hydroxyl volume emission rate (1.6 um channel)()
float OHSe_error(event, altitude)                       // Hydroxyl volume emission rate error ()
float O21De(event, altitude)                            // Oxygen volume emission rate (1.27 um)()
float O21De_error(event, altitude)                      // Oxygen volume emission rate error ()
short solKP(event)                                     // Solar Kp index
short solAP(event)                                     // Solar Ap index
float solf10p7Daily(event)                            // F10.7 flux (daily)
float solF10p781dAvg(event)                           // F10.7 flux (81-day average)
short solSpotNo(event)                                 // Zurich Sunspot Number

```

- Data
  - Event (1-2200)
  - Altitude (0-200 km at 0.4 km intervals)
- Attributes

### ESTIMATED FILE SIZE

<b>1-D Event data:</b>	<b>Bytes</b>
short event(event)	2
long date(event)	4
char mode(event)	1
char tpDN(event)	1
char scAD(event)	1
float tpSolarZen(event)	4
float tpSolarLT(event)	4
short solKP(event)	2
short solAP(event)	2
float solf10p7Daily(event)	4
float solF10p781dAvg(event)	4
short solSpotNo(event)	2
<b>Total (x 2200 events)</b>	<b>68200</b>

<b>2-D Event X Elevation data:</b>	<b>Bytes</b>
float sclatitude(event, altitude)	4
float sclongitude(event, altitude)	4
float scalatitude(event, altitude)	4
float latitude(event, altitude)	4
float longitude(event, altitude)	4
float altitude(event, altitude)	4
float pressure(event, altitude)	4
float pressure_error(event, altitude)	4
float Ktemp(event, altitude)	4
float Ktemp_error(event, altitude)	4

float density(event, altitude)	4
float density_error(event, altitude)	4
float O3L(event, altitude)	4
float O3L_error(event, altitude)	4
float O3S(event, altitude)	4
float O3L(event, altitude)	4
float O3L_error(event, altitude)	4
float H2O(event, altitude)	4
float H2O_error(event, altitude)	4
float NOe(event, altitude)	4
float NOe_error(event, altitude)	4
float OHLe(event, altitude)	4
float OHLe_error(event, altitude)	4
float OHSe(event, altitude)	4
float OHSe_error(event, altitude)	4
float O21De(event, altitude)	4
float O21De_error(event, altitude)	4
<b>Total (x 2200 events x 500 altitude samples)</b>	<b>190080000</b>

**Total Estimated file size (Mbytes):  $0.068200 + 190.08 = 190.1$  Mbytes**